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AMERICAN INSTITUTE OF PHYSICS
335 East 45th Street
New York, NY 10017-3483

EDUCATION & EMPLOYMENT
STATISTICS DIVISION

Tel. 212-661-3404

by Susanne D. Ellis
and Patrick J. Mulvey

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1987–88 SURVEY OF PHYSICS AND ASTRONOMY BACHELOR'S DEGREE RECIPIENTS

Despite the well-publicized current demand for physicists, which is expected to grow throughout the 1990s, no changes can be observed in either the total number of physics bachelors or the proportion of degree recipients who are interested in the graduate studies that lead to a physics career. A detailed look at the postbaccalaureate plans of 2700 new physics and 100 new astronomy bachelors is the focus of this report. All the information comes directly from individual degree recipients of the class of 1988. Because this annual survey dates back to the 1960s, current data can be compared with those of earlier years to reveal trends when significant changes occurred. Highlights of the information presented in this report are:

- For a majority of graduates, their first interest in physics was sparked in high school.
- U.S. minorities comprise almost 10% of the respondents to this survey.
- The median starting salary for physics bachelors increased by 3% over the previous year.

As the number of physics bachelors increased gradually between 1978 and 1985 and subsequently leveled off at 5200 graduates per year, there has been virtually no major change in the distribution of postbaccalaureate plans. The potential graduate students continued to comprise half of the physics bachelors as they form a 3:2 ratio by choosing physics to a related subject of study. The employment-oriented bachelors, who comprise the other half, continue to react to fluctuations in the job market by entering the military service during years when civilian employment appears unattractive to them. **Figure I** presents two sets of bars, one for graduate study and one for employment, thereby indicating the almost even split between the two major career goals. The numerical data for the bars in **Figure I** are shown in **Table I**, which also includes a small group of graduates who are "undecided" about their post-baccalaureate plans.

Figure I. Trends in postbaccalaureate plans of physics bachelors, 1979–1988.

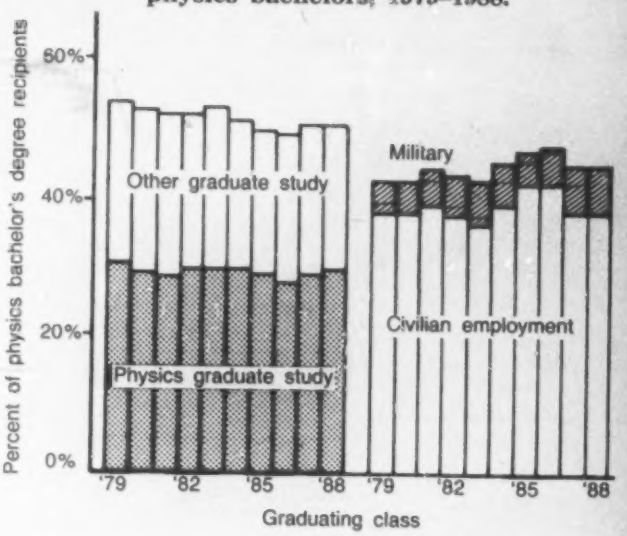


Table I. Postbaccalaureate plans of successive graduating classes of physics bachelors, 1978–1988.

Postbaccalaureate plans	1978–79	1979–80	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88
Physics graduate study	31%	30%	29%	30%	30%	30%	29%	28%	29%	30%
Other graduate study	24	24	24	23	24	22	21	21	22	21
Civilian employment	38	38	39	38	36	40	43	43	39	39
Military service	5	5	6	7	8	6	5	6	7	7
Undecided	2	3	2	2	2	2	2	2	3	3
Total number of physics bachelor's degrees	4416	4440	4513	4558	4795	4878	5188	5214	5253	5152

Member Societies: The American Physical Society • Optical Society of America • Acoustical Society of America • The Society of Rheology • American Association of Physics Teachers • American Crystallographic Association • American Astronomical Society • American Association of Physicists in Medicine • American Vacuum Society • American Geophysical Union

Table II. Characteristics of new physics bachelors, 1987–88.

Characteristics		Postbaccalaureate plans: Graduate study: Physics	Graduate study: Other	Employment	Undecided	Total
Initial interest in physics	Jr. high school or earlier	25%	20%	17%	18%	20%
	High school	50	55	56	62	54
	College	23	23	24	18	24
	Other	2	2	3	2	2
Sex	Female*	13%	18%	16%	17%	15%
	Male	87	82	84	83	85
Citizenship	U.S.	92%	91%	98%	97%	95%
	Foreign	8	9	2	3	5
Age	21 or younger	7%	5%	2%	2%	4%
	22	41	43	31	20	36
	23	25	24	25	28	25
	24–27	18	18	28	41	24
	28 or older	9	10	14	9	11
Minority groups	U.S. blacks	2%	3%	3%	3%	3%
	Other U.S. minorities	7	7	7	7	7
	Foreign minorities	7	9	2	3	5
Transferred from junior college	Yes	11%	10%	13%	13%	12%
	No	89	90	87	87	88
Type of undergraduate institution	Public	57%	49%	67%	63%	58%
	Private	43	51	33	37	42
	PhD-granting	55%	47%	46%	50%	48%
	MS-granting	11	7	11	17	11
	BS/BA-granting	34	46	43	33	41
Total number of bachelors		1525	1077	2375	175	5152
% distribution		30%	21%	46%	3%	100%
Number of respondents		808	572	1258	93	2731

**Percentage of women was adjusted for differential response rate.*

It is often said that physicists develop their interest in that science at an early age. To test this assumption, we included a new question on the form that was sent to physics bachelors in the class of 1988, only one-third of whom are expected to become physicists. Their responses to that question were divided into four time periods and listed as the first of seven characteristics in **Table II**. The senior high schools may be credited with sparking an interest in physics in a majority of the physics bachelors. Only one-fifth of the graduates became interested in physics before studying it in high school. However, if we divide the physics bachelors into groups according to their career goals, a somewhat different scenario emerges. On that basis, only 17% of the employment-oriented graduates, compared with 25% of the potential graduate physics students, developed a very early interest in physics. On the other hand, the percentages of graduates for whom "college" was the introduction to physics, did not vary with respect to their career goals.

The class of 1988 indicates no further increase in women physics bachelors, nor have the proportions of women changed for any of the four subgroups. Foreign graduates continue to comprise only 5% of the total bachelors and four out of five of them remain in the U.S. to enter graduate schools. Changes in characteristics from the previous year include a small increase in bachelors who transferred from junior colleges, and a further decrease in the percentage of employment-oriented bachelors who graduated from private institutions.

Table III. A comparison of the high school physics backgrounds between 1987–88 physics bachelors from public and private institutions.

Type of high school physics		Undergraduate institution: Public	Undergraduate institution: Private	Total: N	Total: %
PSSC*		6%	9%	180	7%
Project physics		4	3	90	4
AP physics		11	19	384	15
General physics		62	63	1617	62
None		17	6	324	12
Total respondents	%	100%	100%		100%
	N	1531	1064	2595	

**PSSC = Physical Science Study Committee.*

Table IV. Postbaccalaureate plans of U.S. and foreign minorities among the physics bachelors of the class of 1988.

Minorities	Postbaccalaureate plans: Graduate study: Physics	Graduate study: Other	Empl.	Total %	N
U.S. blacks	23%	23%	54%	100%	73
U.S. Orientals	29	21	50	100	110
Other U.S. minor.	31	18	51	100	66
Total U.S. minor.	28%	21%	51%	100%	249
Foreign Orientals	47%	40%	13%	100%	39
Other foreign minor.	40	34	26	100	47
Total foreign minor.	43%	37%	20%	100%	86
All respondents	30%	21%	49%	100%	2731

Further differences between graduates from public and private institutions can be found when we examine their educational backgrounds. We find that only 6% of the graduates from private institutions, compared with 17% of the public college graduates, did not take a high school physics course. **Table III** makes these comparisons and lists the types of high school physics courses taken by these two groups of physics bachelors.

The format in which both U.S. and foreign minority groups are presented in Table II tends to obscure the differences in the distributions of their postbaccalaureate plans. Consequently, **Table IV** singles out two major U.S. minority groups (blacks and Orientals) and shows how the career goals of blacks differ significantly from those of all respondents combined while the goals of U.S. Orientals are almost identical with those of all bachelors. The legal status of foreign nationals on student visas makes them ineligible for regular employment and thereby skews the distribution of their postbaccalaureate plans in the direction of graduate studies.

Table V lists six distinct minority groups and the numbers of physics bachelors who identified themselves with each group. The larger groups that are neither predominantly foreign nor predominantly U.S. are divided on the basis of citizenship; the 1988 totals thus reflect further increases among the U.S. contingents of blacks and Orientals. Noteworthy among the four characteristics presented in **Table V** are the concentration of U.S. blacks in the four-year colleges of the Southeast, and the choice of PhD-granting institutions for their undergraduate studies by a majority of the Orientals.

Table V. Selected characteristics of minority physics bachelors, class of 1988.

		Minority group: Black: U.S.	Black: Foreign	Native American Indian	Hispanic: U.S.	Hispanic: Foreign	Oriental: U.S.	Oriental: Foreign	Asian Indian	Arab
	Total	73	6	8	43	10	110	39	23	23
Sex	Female	19	–	–	7	4	14	9	5	8
	Male	54	6	8	36	6	96	30	18	15
Age	21 or younger	–	–	1	1	–	14	1	5	3
	22	19	–	–	8	2	31	10	8	4
	23	21	–	4	11	2	38	7	5	3
	24	12	–	1	9	3	10	7	4	7
	25–27	13	1	–	8	2	11	8	1	3
	28 or older	8	5	2	6	1	6	6	–	1
Region* of bach's inst.	Northeast	17	–	2	5	–	23	8	13	1
	Southeast	32	3	4	7	2	8	5	–	3
	Central & Mountain	19	3	1	18	5	18	10	2	11
	Pacific	5	–	1	13	3	61	16	8	7
Type of bach's inst.	PhD-granting	20	1	3	22	4	75	25	19	15
	MS-granting	13	–	2	6	1	13	1	1	4
	BS/BA-granting	40	5	3	15	5	22	13	3	4

**Regions: Northeast = New England, Middle Atlantic; Southeast = South Atlantic, East South Central; Central = East North Central, West North Central, West South Central.*

Table VI. Sources of anticipated support for first-year graduate study*, 1986–88.

Sources of support	Students planning: Physics graduate study 1986	1987	1988	Other graduate study 1986	1987	1988
Teaching assistantship	51%	52%	51%	19%	16%	15%
Research assistantship	10	12	11	14	15	20
Fellowship	11	12	14	12	18	12
Family, savings, loan	4	5	4	22	23	23
Part-time employment	4	2	4	11	10	15
Other	6	3	1	9	5	2
Multiple: TA/RA	6	8	6	7	5	5
Multiple: TA/Fellowship	5	4	6	4	1	3
Multiple: TA/Family, savings, loan	3	2	3	2	7	5
	100%	100%	100%	100%	100%	100%
Graduate study status: full-time	91%	92%	91%	81%	81%	85%
Graduate study status: part-time	9	8	9	19	19	15
Total number of full-time students	1455	1545	1525	1100	1132	1077

**The information was reported for September of each academic year.*

The major sources of support available to bachelors who enter graduate programs fall into two broad categories: (1) assistantships and fellowships funded by the universities or government agencies, and (2) funds provided by the students such as family savings, loans, or part-time employment. The proportions in which these sources of support are offered to two groups of physics bachelors differ significantly from one another as shown in **Table VI**. For example, teaching assistantships constitute not only the most common type of support for those who enter graduate physics programs, but also the only source of support for a majority of that group. By contrast, the most common type of support for physics bachelors who enter other disciplines of graduate study are family funds, savings, or loans; only one-third of that group were able to secure teaching or research assistantships.

The lower portion of **Table VI** is based on a somewhat larger group of new physics bachelors because it includes those who have accepted full-time employment and pursue graduate studies on a part-time basis. Again we call attention to the difference between the two groups of graduate students: The physics students include a smaller proportion of part-time students than those who entered "other graduate study."

It would be wrong to assume that the employment-oriented physics bachelors ignore altogether the graduate study necessary to become a physicist. In answer to a question concerning their future plans for graduate study in physics, 20% of that group perceived their employment as a one-year interruption in their studies and over half of that group were less precise about whether they will resume their study of physics, but expressed a desire to do so at some future date. Approximately 25% specified "no interest in graduate studies as long as their employment remains challenging."

Irrespective of how serious the graduates may be about their employment plans, they comprise so large a contingent of all physics bachelors each year that an analysis of the demand for them has become an important part of this survey. To accomplish that we asked each employment-oriented bachelor for the number of job offers he or she received, which provides us with a scale of no offers, one offer, and multiple offers. **Table VII** presents these data consecutively for the most recent five years and adds 1980 and 1975 for comparison purposes. The first category "zero job offers" may require some clarification so as not to mistake it for a general unemployment rate; it refers to the time immediately after graduation when many bachelors have allotted insufficient time to explore the job market. **Table VII** shows no change from the previous summer but indicates a lower demand than that recorded in the early 1980s when a larger percentage of graduates reported multiple offers to choose from.

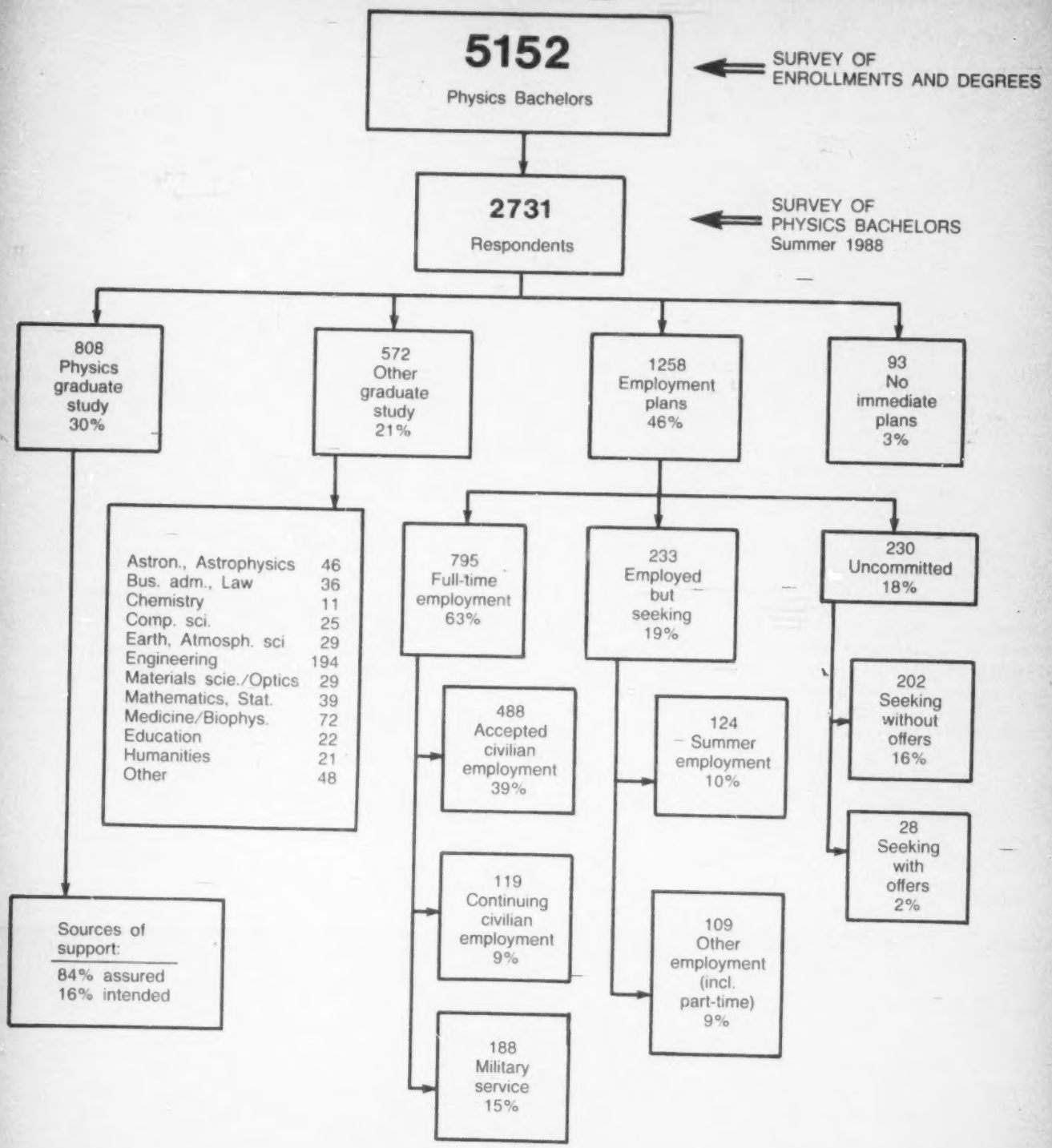
A comprehensive view of the four groups of physics bachelors defined in **Table I** is presented in **Figure II**. The specific details of this flow diagram allow us to compare the groups who reported firm commitments with those whose plans are still pending. Among the former, we find that most of the graduate physics students' sources of support fell into the "assured" category, and the major disciplines chosen by the graduate students who intended to enter "other graduate study" can also be considered

Table VII. Changes in employment outlook for new physics bachelors, 1975–1988.

Number of job offers at graduation	Summer 1975	Summer 1980	Summer 1984	Summer 1985	Summer 1986	Summer 1987	Summer 1988
0	17%	10%	13%	14%	13%	15%	16%
1*	56	50	54	59	66	68	67
2 or more	27	40	33	27	21	17	17

**Bachelors who enter the military service are included here.*

Figure II. Postbaccalaureate plans of physics bachelors of the class of 1988.



firm commitments. On the other hand, the employment-oriented group needs to be divided into three subgroups that indicate the extent to which their employment plans materialized. The largest of the three subgroups, comprising 63% of the total, had secured full-time employment while 19% were obliged to accept temporary or part-time work instead of the potentially permanent positions they were actually seeking. Most of the remaining 18% were still uncommitted by the time they responded to this survey.

Table VIII. Initial employment of physics bachelors, 1978–88.

Type of employer	Percentage of employed bachelors									
	1978–79	1979–80	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88
Industry {manufacture	40%	41%	40%	38%	33%	38%	35%	30%	28%	28%
Industry {service	18	20	22	22	20	16	20	18	18	25
High school	6	3	2	3	4	4	4	7	6	5
College or university	4	3	4	4	4	5	3	4	4	4
Government {civilian	7	8	7	7	10	12	14	13	11	9
Government {military	15	16	21	24	27	24	23	28	32	28
Other	10	9	4	2	2	1	1	–	1	1
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

A closer look at the bachelors who had accepted the full-time entry level positions they sought, leads us to **Table VIII** which compares the 1988 graduates with their counterparts of earlier years. A conspicuous trend evident from this table is the steady decline since 1980 of industrial manufacturing jobs, which is offset by the increasing proportion of bachelors who entered the military service. The employment we categorize as "service industry" includes companies eager to hire college graduates with a technical or mathematical orientation; but these graduates will probably not utilize the specific physics training they received. This area showed a most dramatic increase in 1987–88.

Although a physics bachelor is well prepared to teach physics at the secondary school level, only a small proportion of the graduates are attracted to a high school teaching career because the salaries are so low. **Table IX** compares the median monthly starting salaries paid by different employers; they range from $1550 offered by the high schools to the highest median of $2380 paid to women in manufacturing industries. The overall median monthly starting salary for all employers combined was $1930 and represents a 3% increase over the 1987 median.

The employment-oriented graduates of **Figure II** include 119 bachelors who had decided to remain with employers for whom they worked before receiving their bachelor's degrees. This group had been excluded from **Tables VIII** and **IX** because these degree recipients did not seek employment in 1988 and their salaries were generally higher. However, **Table X** includes the group described as "continuing civilian employment" because its members hold full-time potentially permanent positions whose work activities and employers are of interest.

The bottom section of **Table X** supports the statement made earlier in this report that bachelors who work in a service industry are unlikely to make extensive use of their physics training.

Table IX. Starting salaries of physics bachelors, class of 1988.

Type of employer	Men (449 reported salaries)		Women (88 reported salaries)		Total (537 reported salaries)	
	Dist. by employer	Median monthly salary	Dist. by employer	Median monthly salary	Dist. by employer	Median monthly salary
Industry {manufacture	28%	$2310	28%	$2380	28%	$2350
Industry {service	24	2060	27	1920	25	2060
High school	5	1550	6	1550	5	1550
College or university	4	1700	6	1700	4	1700
Government {civilian	5	2030	13	1950	6	2020
Government {military	31	1650	10	1650	28	1650
Fed. Fund. Res. Ctr.	2	2200	4	1900	3	2050
Nonprofit organization	1	**	6	**	1	**
Total	100%	$1925	100%	$2020	100%	$1930

***Insufficient data.*

Table X. Full-time employment* of new physics bachelors, class of 1988.

Work activity		Type of employer: Industry manufacture	Industry service	High school	Government civilian	Government military	Coll. univ.	Nonprf. org.	Total N	Total %
Teaching		–	3	42	5	2	3	4	59	7%
Research & development		56	17	–	32	9	16	2	132	17
Development & design		89	31	–	11	6	3	2	142	18
Programming		38	39	–	6	5	9	3	100	13
Specialized training**		2	7	–	2	107	–	–	118	15
Marketing		6	19	–	1	–	–	–	26	3
Other professional work		9	21	–	7	55	–	2	94	12
Skilled labor		21	29	–	6	–	10	–	66	8
Other		11	36	1	6	3	1	–	58	7
Total	N	232	202	43	76	187	42	13	795	
	%	29	25	5	10	24	5	2		100%
Use of physics training	Extensive	38%	14%	62%	55%	27%	54%	33%		33%
	Little	51	37	23	41	60	41	59		47
	None	11	49	15	4	13	5	8		20

The employment of these 795 graduates includes both newly accepted positions as well as those in which graduates are continuing. Excluded are graduates in temporary and summer employment.

***Training paid for by employer includes pilot or navigator training by the military.*

ASTRONOMY

There are 56 undergraduate astronomy degree programs in the U.S. and 45 of them granted 181 bachelor's degrees in 1987–88. Although these new astronomy bachelors comprise only 3% of the physics degree recipients for that year, their postbaccalaureate plans are surprisingly similar. The information from 100 individual graduates is presented in two tables and a flow diagram each of which divides the respondents on the basis of their career goals. For example, **Table XI** presents six characteristics which show, among other findings, that the potential graduate students tend to be

Table XI. Characteristics of new astronomy bachelors, 1987–88.

Characteristics		Postbaccalaureate plans: Graduate study Astronomy N	Graduate study Other N	Employment N	Undecided N	Total %
Initial interest in physics	Before high school	19	7	19	–	45%
	High School	9	11	21	1	42
	College	6	2	5	–	13
Sex	Female	6	5	9	–	20%
	Male	28	15	36	1	80
Citizenship	U.S.	31	20	45	1	97%
	Foreign	3	–	–	–	3
Type of high school physics	PSSC*	1	2	4	1	8%
	Project physics	–	1	3	–	4
	AP physics	5	5	6	–	16
	General physics	27	12	25	–	64
	None	1	–	7	–	8
Age	21	3	2	1	–	6%
	22	20	7	14	1	42
	23	5	7	18	–	30
	24	4	3	6	–	13
	25 or older	2	1	6	–	9
Type of bachelor's institution	PhD-granting	24	17	36	1	74%
	MS-granting	2	–	4	–	6
	BS/BA-granting	8	3	5	–	20
	Public	23	13	27	1	64%
	Private	11	7	18	–	36
Total respondents		34	20	45	1	100
Total number of astronomy bachelors		62	36	81	2	181

*PSSC = Physical Science Study Committee.

Table XII. Postbaccalaureate plans of successive graduating classes of astronomy bachelors, 1978–1988.

Postbaccalaureate plans	1978–79	1979–80	1980–81	1981–82	1982–83	1983–84	1984–85	1985–86	1986–87	1987–88
Astronomy graduate study	28%	35%	24%	29%	38%	38%	35%	40%	51%	34%
Other graduate study	19	17	13	25	17	31	18	16	14	20
Employment	51	43	59	45	41	28	44	38	34	45
Undecided	2	5	4	1	4	3	3	6	1	1
Total number of astronomy bachelors	165	165	156	181	138	137	145	169	172	181

younger than the employment-oriented bachelors, whereas the proportion of women did not vary with respect to career goal. The first characteristic is based on a new question which explores the origins of their interests in physics. "Prior to high school" drew the largest number of responses, and compared to the physics bachelors, their interest in this discipline started considerably earlier.

Table XII compares the current postbaccalaureate plans with those of earlier years and shows the total number of bachelors degrees reported by department chairpersons since 1978. Additional details on the two groups of graduate students are offered in **Figure III** which also shows that nine graduates encountered difficulties in finding suitable employment.

The size of the employment group among the new astronomy bachelors may appear large when taking into consideration that graduate study is essential to becoming an astronomer. However, the graduate astronomy population indicates that it is increasingly common to work for one or two years before entering graduate school.

Figure III. Postbaccalaureate plans of astronomy bachelors of the class of 1988.